Factors Associated with Weaning Success of Mechanically Ventilated Acute Traumatic Spinal Cord Injury Patients: A Retrospective Cohort Study

Hannah Uhlig-Reche, MD[1], Emmanuel Chigozie Achilike, MD, MPH[2], Colton W. Reeh, BSA[1], Radha Korupolu, MD, MS[1]
[1]Department of Physical Medicine and Rehabilitation, McGovern Medical School, The University of Texas Health Science Center, Houston, Texas
[2]Department of Physical Medicine and Rehabilitation, Baylor College of Medicine

UTHealth | McGovern Medical School
The University of Texas Health Science Center at Houston
PHYSICAL MEDICINE AND REHABILITATION
Restoration. Recovery. Re-integration

TIRR MEMORIAL HERMANN Rehabilitation & Research

Introduction

- An individual's dependency on mechanical ventilation (MV) following acute spinal cord injury (SCI) increases morbidity, mortality, hospital costs, and quality of life. [1]
- Identifying individuals at high risk of weaning failure allows providers to pursue intervention such as phrenic nerve pacing (PNP), diaphragm pacing (DP) and abdominal functional electrical stimulation (FES) to improve a patient's opportunity to successfully wean from MV. [2-8]
- Current literature suggests lower level of SCI, higher Glasgow Coma Score at admission, and lower thiobarbituric acid-reactive substance levels are associated with higher success of weaning from extubation.[9,10]
- The literature also suggests predictors such as older age, higher injury severity scores, pulmonary mechanical insufficiency, inadequate pulmonary toilet, sedation or neurological issues, longer length of stay (LOS) in the hospital or intensive care unit, higher rates of ventilator-associated pneumonia, and tracheostomy lead to extubation failure, re-ventilation, and ventilator dependence.[9-12]
- This study's objective was to compare baseline characteristics between those successfully weaned versus those and who failed weaning in an acute inpatient rehabilitation hospital (AIR) in order to identify predictors for weaning success.
- The study's population was not weaned in acute care hospitalization, prior to AIR admission, suggesting a population consisting of more sever SCI.

Materials & Methods

Design

- Retrospective study of electronic medical records.

Participants

- Adult patients admitted to AIR during 2015-2019 with an acute traumatic SCI requiring continuous MV support via tracheostomy (Figure 1).

Outcomes

- Determine incidence of MV weaning success.
- Compare baseline characteristics between those who weaned successfully from MV (Group I) and those who were not (Group II) in order to identify predictors, and their corresponding thresholds, of weaning success.

Analysis

- Baseline variables and variables of interest were compared using two-sample unpaired t tests, Wilcoxon rank-sum, or Chi square testing as appropriate
- Univariate analysis was used to determine which variables were statistically significant in terms of the risk of requiring MV
- Logistic regression was used to calculate odds ratio while adjusting for potential confounders
- We used Receiver Operating Characteristics (ROC) curves to measure the discriminatory capacity of quantitative variables to predict the risk of the need for MV. The area under the curve (AUC) measures the discriminatory capacity of the model considering scores lower than 0.75 have a poor predictive discrimination and from 0.76 to 1.0 to be indicative of a good/excellent predictive discrimination. Likelihood ratios (LR) are reported.

Population Subsets and Exclusion Criteria

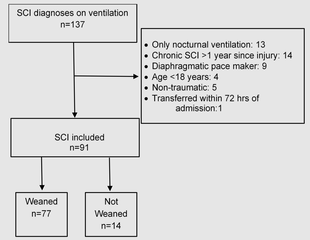

Figure 1.Inclusion/Exclusion criteria and group counts

Results

- Incidence of successful MV weaning was approximately 85%.
- Median age was higher in Group II compared to Group I (50 years vs. 37 years, p=0.17),
- Group I was admitted a median of 8 days earlier to AIR after SCI (p=0.04).
- The predominant level of neurology injury for Group I was C4-C6 (64%) vs C1-C3 (71%) in Group II (p<0.001).
- Mean VC at admission to AIR for Group I was 12 ml/kg PBW vs 3 ml/kg PBW in Group II (p<0.001).
- Median days on MV in AIR were 32 in Group I compared to 52 in Group II (p<0.01).
- For Group I, the median (IQR) pre-weaning days in AIR was 12 (7-18) and median (IQR) ventilator weaning days was 19 (18-21).
- There was a higher incidence of pneumonia during AIR in Group II with 17 episodes of pneumonia per 1000 ventilator days compared to Group I having 5.64 episodes of pneumonia per 1000 ventilator days (p=0.002) (Figure 2).
- The majority of those weaned were discharged home (79%) compared to only 36% in Group II (p<0.01). .

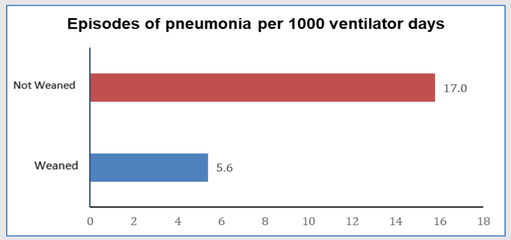

Figure 2. Incidence of number of episodes of pneumonia, per 1000 ventilator days, in Group I (Not-Weaned) versus Group II (Weaned).

Results (cont.)

Predictors of weaning success:

- People who failed weaning had had lower VC at admission to AIR and higher neurological level of injury.

Vital Capacity: ROC curves were generated and the AUC for VC at admission in ml/kg PBW was 0.95 with 95% CI 0.91-0.99 (Figure 3). For the cut-off value of 5.8 cc/kg PBW, sensitivity is 92%, specificity is 86% with LR+ of 6.4 and LR- of 0.09. With this cut-off value, 91% were correctly classified. Logistic regression revealed that if VC at admission is ≥5.8 cc PBW then odds of weaning off ventilator is 57 times higher (95% CI: 10-309; p=0.00) compared to people with VC of <5.8 cc/kg PBW at AIR admission after adjusting for age.

ROC Curve for Admission Vital Capacity

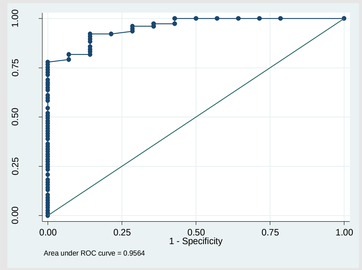

Figure 3. ROC curve showing AUC for VC at admission in ml/kg PBW with cut-off value of 5.8 cc/kg PBW

Neurological Level of Injury: ROC curves were generated and the AUC for neurological level of injury was 0.81 with 95% CI 0.69-0.95 (Figure 4). For the cut-off value of neurological level of C2 and above, sensitivity is 93% and specificity is 58% with LR+ of 2.2 and LR- of 0.11. With this threshold, 89% were correctly classified. Logistic regression revealed that if neurological level is C3 or below (i.e. C4, C5), then odds of weaning off ventilator is 11 times higher (95% CI: 2-60; p=0.005) compared to people with neurological level above C3 (i.e. C1 and C2) after adjusting for age.

ROC Curve for Neurological Level of Injury

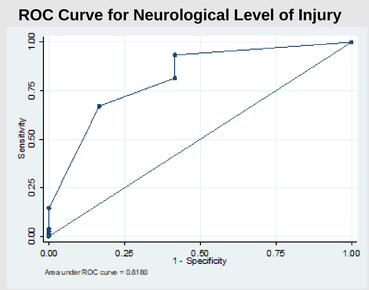

Figure 4. ROC curve showing AUC neurological level of injury with cut-off value of C3 and above

Results (cont.)

Table 1 – Demographics & Baseline Characteristics

	All Patients (n= 91)	Weaned (n= 77)	Not Weaned (n = 14)	P Value
Age, years, Median (IQR)	37 (24-57)	37 (23-55)	50 (27-69)	0.17
BMI, Median (IQR)	27 (23-32)	27 (23-32)	26 (22-32)	0.93
SCI to AIR hospital admission in days, Median (IQR)	24 (18-35)	22 (17-34)	30 (24-51)	0.04
Male, n (%)	72 (79%)	60 (78%)	12 (86%)	0.51
Smoking history, n (%)	40 (44%)	33 (43%)	7 (50%)	0.65
Lung Disease Prior to Admission	9 (10%)	8(10%)	1(7%)	0.7
Concomitant TBI/CVA, n (%)	24 (26%)	19 (25%)	5 (36%)	0.4
Concomitant thoracic injuries*, n (%)	27 (30%)	22 (29%)	5 (36%)	0.59
Pneumonia in acute care, n (%)	80 (88%)	68 (88%)	12 (86%)	0.78
Pneumonia developed within 48 hrs after admission to AIR, n (%)	16 (18%)	14 (18%)	2 (14%)	0.7
Admitted to AIR on tube feeding, n (%)	88 (97%)	14 (100%)	74 (96%)	0.4
Atelectasis at Admission, n (%)	70 (77%)	60 (78%)	10 (72%)	0.5
VC at admission in ml/kg pbw, Mean (SD)	11 (5.7)	12 (4.9)	3 (2.8)	0.00
AIS				
A	54 (59%)	45 (58%)	9 (64%)	0.2
B	16 (18%)	15 (19%)	1 (7%)	
C	15 (16%)	13 (17%)	2 (14%)	
D	2 (2%)	2 (3%)	0 (0%)	
Unknown	4 (4%)	2 (3%)	2 (14%)	
Neurological level				
C1-C3	35 (38%)	25 (32%)	10 (71%)	0.00
C4-C6	51 (56%)	49 (64%)	2 (14%)	
T2-T4	2 (2%)	2 (3%)	0 (0%)	
Unknown	3 (3%)	1 (1%)	2 (14%)	

Table 1 - Demographics and Baseline Characteristics

Abbreviations: SD: Standard deviation; PBW: predicted body weight; IQR: Interquartile range, AIR: Acute inpatient rehabilitation facility; SCI: Spinal cord injury; TBI: Traumatic brain injury; CVA: Cerebrovascular accident; AIS: ASIA impairment

* Thoracic injuries resulting in pneumothorax, sternal fractures, hemothorax, pneumo-mediastinum, pulmonary contusion were included.

"Lung Disease Prior to Admission" includes COPD, asthma and pre-existing restrictive lung disease.

Conclusions

•VC at admission to AIR can predict weaning success better than neurological level of injury.

•The neurologic level of SCI tended to be higher in the group that did not successfully wean.

•Those unsuccessfully weaned had more days between SCI and AIR admission which may be indicative of sicker patients.

•These results expand on and supplement earlier findings, ultimately helping us better understand which patients with SCI may successfully wean from MV in acute inpatient rehabilitation setting, and potentially beyond.

Acknowledgements:

Ellia Ciammaichella, DO, JD; Patrick John Mollett, DO

References:

Celebrating 25 years of excellence in patient care, education and scientific discovery